

FINAL PROJECT
HEAT TRANSFERS ANALYSIS OF CAR RADIATOR
FOR COOLING SYSTEM OF
TOYOTA RUSH 1.5 M/T



RESEARCH PAPER

**Submitted as a Partial Fulfillment of the Requirements for Getting the
Bachelor Degree of Engineering in Automotive Department**

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I assert verily that the research entitles:

HEAT TRANSFERS ANALYSIS OF CAR RADIATOR FOR COOLING SYSTEM OF TOYOTA RUSH 1.5 M/T

That made to fulfill some of requirements to get bachelor degree of Engineering in Automotive Department of Muhammadiyah University of Surakarta, as far as I know is not a plagiarism of a research that has been published, except the information source that used to solve the problem.

Surakarta, November 2011

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MOTTO

We are what we repeatedly do.
Excellence, therefore, is not an act but a habit.
(Aristotle)

Knowing is not enough; we must apply.
Willing is not enough; we must do.
(Johann Wolfgang von Goethe)

Every artist was first an amateur.
(Ralph Waldo Emerson)

You cannot dream yourself into a character;
you must hammer and forge yourself one.
(Henry David Thoreau)

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TABLE OF CONTENT

	Page
TITLE.....	i
APPROVAL	ii
ACCEPTANCE	iii
TESTIMONY	iv
MOTTO.....	v
ACKNOWLEDGMENT	vi
TABLE OF CONTENT	viii
LIST OF FIGURES	xi
LIST OF TABLES	xiii
LIST OF EQUATIONS	xiv
ABSTRACT	xv
CHAPTER I INTRODUCTION	
1.1 Background	1
1.2 Car Cooling System	2
1.3 Objectives.....	4
1.4 Problem Limitations	5
1.5 Methodology	5
1.6 Systematic Writing	6
CHAPTER II REVIEW OF LITERATURE	
2.1. Study of Literature	7

2.2. Fundamental of Theory.....	9
2.2.1 Conduction.....	9
2.2.2 Convection.....	11
2.2.3 Radiation.....	14
2.2.4 Fins.....	17
2.2.5 Mass Flow Rate.....	20
2.2.6 Friction.....	23
2.2.7 Turbulent Flow.....	27
2.2.8 Laminar Flow.....	29
2.2.9 Pump.....	31

CHAPTER III COOLING SYSTEM OF TOYOTA RUSH 1.5 M/T

3.1 Flow Chart of Research.....	33
3.2 Cooling System of Toyota Rush 1.5 M/T.....	34
3.2.1 Combustion Process.....	35
3.2.2 Cooling System.....	36
3.2.3 Main Components.....	40

CHAPTER IV CALCULATION ANALYSIS

4.1 Heat Transfer Analysis.....	46
4.1.1 When Thermostat Opens.....	46
4.1.2 Segment Analysis (When Thermostat Opens).....	52
4.1.3 When Fan Starts.....	57
4.1.4 Segment Analysis (When Fan Starts).....	63
4.2 Discussion.....	68

CHAPTER V CONCLUSION AND SUGGESTION

5.1 Conclusion..... 70

5.2 Suggestion 70

REFERENCES 71

APPENDIX

LIST OF FIGURES

	Page
Figure 1.1 Heat Balance In Gasoline Engine.....	1
Figure 1.2 Cooling System When Thermostat Closed.....	3
Figure 1.3 Cooling System When Thermostat Open	4
Figure 2.1 Heat Conduction from Warm Air to a Cold Canned Drink Through The Wall of The Aluminum Can	10
Figure 2.2 The Cooling of a Boiled Egg by Forced and Natural Convection	12
Figure 2.3 Heat Transfer by Radiation Can Occur Between Two Bodies, Even When They are Separated by a Medium Colder Than Both of Them	15
Figure 2.4 Three Typical Cases for One-Dimensional, Constant-Cross- Section Fins.....	17
Figure 2.5 Two Examples of Fins With a Cross-Sectional Area that Varies With Distance from The Base. (a) Straight Triangular Fin. (b) Annular Fin of Constant Thickness.	19
Figure 2.6 The Normal Velocity V_n for a Surface is The Component of Velocity Perpendicular to The Surface.....	21
Figure 2.7 The average velocity V_{avg} is defined as the average speed through a cross section	22
Figure 2.8 The Volume Flow Rate is The Volume of Fluid Flowing Through a Cross Section Per Unit Time.....	23
Figure 2.9 Turbulent Flow.....	28
Figure 2.10 Laminar Flow.....	29

Figure 2.11	Centrifugal Pump	31
Figure 3.1	Flow Chart of Research	33
Figure 3.2	Four Strokes Cycle	34
Figure 3.3	Typical Temperature Values of Gasoline Engine Operating at Normal Steady State Conditions (Temperatures are in Degrees C).....	36
Figure 3.4	Cooling System Of Toyota Rush 1.5 M/T.....	37
Figure 3.5	Water Pump Assembly	38
Figure 3.6	Thermostat Part Location	39
Figure 3.7	Radiator Assembly	40
Figure 3.8	Car Radiator	41
Figure 3.9	Thermostat	42
Figure 3.10	Radiator Cap	43
Figure 3.11	Cooling Fan.....	44
Figure 3.12	Water Pump	45
Figure 4.1	Radiator Constructions	46
Figure 4.2	Radiator Constructions	52
Figure 4.3	Radiator Constructions	57
Figure 4.4	Radiator Constructions	63

LIST OF TABLES

	Page
Table 2.1 Viscosity and Kinematic Viscosity of Eight Fluids at 1 atm and 20°C.....	26
Table 4.1 Result of Calculation Analysis.....	68
Table 4.2 Reynold and Nusselt Number due to Air Velocity	69

LIST OF EQUATIONS

1. Reynolds number (R_{eD}): $R_{eD} = \frac{\rho \times V \times D_h}{\mu}$
2. Diameter hydraulic (D_h): $D_h = \frac{4 \times A_c}{P}$
3. Outside pipe heat transfers convection coefficient (h_o): $h_o = \frac{k \times N_{uD}}{D_h}$
4. Fin parameters (m): $m = \left[\frac{h_o \times R_{fM}}{k \times A_{fm}} \right]^{\frac{1}{2}}$
5. Efficiency of a fin (η_f): $\eta_f = \frac{\tanh(m \times l)}{m \times l}$
6. Total efficiency of fins (η_o): $\eta_o = 1 - \left[\frac{N \times A_f}{A_t} \times (1 - \eta_f) \right]$
7. Thermal resistance of fins (R_f): $R_f = \frac{1}{\eta_o \times h_o \times A_t}$
8. Heat capacity rate (C_1): $C_1 = 1 + \left[\eta_f \times h_o \times A_f \left(\frac{R_f}{A_t} \right) \right]$
9. Total fins efficiency at connection ($\eta_{o(c)}$): $\eta_{o(c)} = 1 - \left[\frac{N \times A_f}{A_t} \times \left(1 - \frac{\eta_f}{C_1} \right) \right]$
10. Thermal resistance through connections (R_t): $R_t = \frac{1}{\eta_o \times h_o \times A_t}$
11. Logarithmic Mean Temperature Difference (LMTD): $LMTD = \frac{\Delta T_2 - \Delta T_1}{\ln \left(\frac{\Delta T_2}{\Delta T_1} \right)}$
12. Heat transfer rate through fins (\dot{Q}_o): $\dot{Q}_o = \frac{1}{R_f} \times LMTD \times F_C$
13. Efficiency of radiator: $\eta = \frac{Q_{actual}}{Q_{segment \ analysis}}$

ABSTRACT

DAVID SINURAT. D700070010. HEAT TRANSFERS ANALYSIS OF CAR RADIATOR FOR COOLING SYSTEM OF TOYOTA RUSH 1.5 M/T. MUHAMMADIYAH UNIVERSITY OF SURAKARTA. 2011.

Although gasoline engines have improved a lot, they are still not very efficient at turning chemical energy into mechanical power. Most of the energy in the gasoline (perhaps 75%) is converted into heat, and only 25% of total energy produced in gasoline engine which converted into effective work. Therefore, it is the job of the cooling system to take care of that heat. The objectives are to investigate heat transfer rate through radiator and create simple segment analysis which then compared to full radiator analysis.

Cooling systems are designed to allow the engine to reach a normal operating temperature as soon as possible and then maintain that operating temperature over the course of driving in a wide range of ambient temperature ranges and finally, to prevent any overheating that might occur. Coolants in the closed loop system are designed to absorb engine heat and transfer it to the radiator so that through convection and thermodynamics heat transfer may occur. A radiator is a type of heat exchanger. It is designed to transfer heat from the hot coolant that flows through it to the air blown through it by the fan. In order to obtain the result, it is important to know inlet and outlet temperature of radiator and air which passing through radiator.

Total heat transferred by car radiator is vary depend on speed of vehicle which will affect air flow speed through radiator. When thermostat opens total heat transferred by radiator is 13274.61 Btu/hr. Segment analysis for radiator when thermostat opens is 15842.1 Btu/hr. Therefore, heat transfer efficiency of car radiator of Toyota Rush 1.5 M/T is 83.6%.

Key words: car cooling system, heat transfer, and radiator